Universe Scientific Publishing
CONSTRUCTION PRACTICE

Discussion of Issues on Waterproof Construction of Metro Station

Yuan Liu*
The Third Branch Company of China Railway Tunnel Group, Chongqing 400021, China

ABSTRACTS With the stable economic growth and rapid urban construction, urban metro is becoming the major transportation tool in medium and large scaled cities. Metro provides convenient and effective transportation services to the public. During the metro construction, water leakage issues occurred frequently and creates huge impacts on the construction and usage of metros. This paper analyzes the causes of metro station water leakage and states the detailed metro station foundation surface and waterproof layer construction techniques, waterproof techniques on construction joints and induction joints, concrete waterproof techniques and waterproof materials leaking stoppage techniques. It is critical to adopt scientific waterproof measures in construction which secure the metro construction quality. It has significant meanings to facilitate a sustainable development of metro construction corporates.

KEYWORDS
Metro construction
Waterproof
Water leakage
Construction techniques

1. Introduction

In the metro construction processes, certain soil stratum's water content is higher in certain metro stations. If proper waterproof measurement were not taken, it would develop impacts on the internal structure of the station and shorten the service life, or even trigger quicksand and piping which would damage the overall station's structure. Proper waterproof measurement able to prevent the leakage and secure the quality the metro station construction.

2. Reasons for Water Leakage in Metro Station

There are many reasons that may leads to water leakage in metro station. Through analysis and investigations of the leakages, the prime causes are as follows:

2.1. Water Leakage on Foundation Surface and Waterproof Layer

In the entire metro construction, several of the projects would be outsourced. The outsourced foundation surface and waterproof failed to meet the requirements, for instance, the flatness of the surface did not meet requirements; the water did not leak through stoppage handling; the reinforcing steel bar broke the completed waterproof layer before being fixed in time; the waterproof layer was insecure or uneven; there were places uplifted or dropped on waterproof layer due to the pressure of concrete; all of those basis would promote water leakage and affect the quality of the metro station.

2.2. Leakage due to Construction Joints and Induction Joints

Typically, the vertical construction joints may overlap with induction joints in construction. The horizontal joints would be 30 cm higher than the middle plate or floor. Some leakage issues in metro stations were caused by that the vertical construction joints only had waterproof paint on cement-based joints and grouting pipelines; in concrete poured parts, the grouting pipelines were affix and unable to work or the horizontal joint surface had sundries and laitance and it was not cleaned thoroughly. The adhesive paint were not painted uniformly or there was no steel plate used to block leaking purpose regulated in design and etc. They would all cause water leakage. The water leakage at induction joints and deformation joints were due to the following reasons: Improper fixation of water-stop belts or incorrect location; the water-stop steel plates and water-stop belts were not firm that there were gap or

doi: 10.18686/utc.v2i1.6
Received: October 9, 2015; Accepted: November 1, 2015; Published online: December 3, 2015

*Corresponding author: The Third Branch Company of China Railway Tunnel Group, Chongqing 400021, China. E-mail: liuyuan12345654@sina.com

bubbles in the area that contacts concrete or the concrete was not dense. There were also water leakage caused by the molds which were not supported firmly during the concrete construction on one side [2].

3. Waterproof Construction and Leakage Stoppage Techniques in Metro Station

3.1. Base layout and waterproof layer Techniques in Station

During the metro station construction process, when the waterproof layer on the floor of the station was done prior to the binding of reinforcing steel bars, concrete protection layer should be incorporated on the waterproof layer to prevent the damages of waterproof layer caused by construction of steel bar on it. Before paving the membrane waterproof layer, the pre-buried devices and pipelines construction should be completed with waterproof process. It is prohibited to drill a hole on it after completion of membrane waterproof construction. The structure of the membrane waterproof should be simple and firm. The surface should be cleaned, fixed and dry. It was forbidden to do constructions in rainy, snowy days or the wind force was over 5. The standard environment temperature should be within 5–35 ℃. Rain-proof measurement will take into account if the construction work was conducted in rainy days. However, the heat preservation measurement should be considered when construction work was conducted in winter days [1].

3.2. Waterproof Techniques to Construction Joints and Induction Joints

This will enhance the waterproof process to construction joints in the design in construction and introduce water-stop steel plate or rubber water-stop belts. The implementation should be under strict supervision in accordance with designing requirements. The sundries and laitance on surface should be cleaned regularly and then paint cement-based capillary crystalline waterproof materials. 3–5 cm cement mortar paved on it and concrete grouting implemented accordingly. If center-buried water-stop belts were used, ensure the correct location and solidity of the construction. The hollow in the center overlapped with the centers of the induction joints and deformation joints, and be located at the position of half thickness of the waterproof reinforce concrete's position. It must be kept at straight position. It is constructed into circular arc at the corner which radius is within 3 cm. The plastic were connected to water-stop belts using hot melting method. The connection should be firmed without leaking. Then, intensity of concrete should conform to the related requirements. When removing the molds, the damage to the water-stop belts should be avoided. The main frame and auxiliary parts of the Metro station should use SBS or EVA waterproof membrane. It should provide protection to the water-proof membrane on the main frame and auxiliary parts to prevent damages on the water-proof membranes. Make the main frame and auxiliary parts bond rigid with waterproof membranes [4].

3.3. Concrete Waterproof Techniques

Part of the water leakage occurred in between the cracks of the concrete in the construction. To prevent the concrete cracks, full attention was given during the operation of concrete. The proportion of waterproof concrete should meet the requirements. The ratio of cement and sand should be within 1:1.5–1:2.5; the ratio of water and cement should be 0.55:1. Volume of water usage was reduce as much as possible. The slump should be controlled within 12 cm; the loss value of slump should be within 2 cm/h; the total value should be within 4 cm. The premixed concrete initial setting time should be 6–8 hour. The ingredients should be weighed according to the requirements of the proportion. The high frequency mechanical vibration compaction time should be 10–30 second. To prevent less vibration, missed vibration or over vibration, it should be operated under continuous grouting in the entire process and reduce the gaps and joints. There should not be any leave joints between bottom floor and top floor. The construction joints must strictly follow the regulation in the design. In large area concrete construction, it is necessary to carry out humidity and temperature maintenance. The temperature difference between the surface and the center of the concrete should be within 25 ℃. The temperature difference between the concrete surface and the air should be within 25 ℃. The maintenance period should be over 2 weeks. The temperature when inserting into the molds should be within 5 ℃ in winter at the same time the greenhouse method and hot process should be taken to ensure the surface of the concrete is wet and not dehydration [3].

3.4. Leakage Stoppage Technique of Waterproof Materials

The wet stains on walls and leaking locations of a metro station able to use waterproof materials to stop water leaking process. Groove the wet and leaking position at 4cm in width and 2 cm in depth. The cutting edges will need to be clean without loose. The waterproof materials should be painted into three layers. Firstly, clean the surface with dry cloth; paint the waterproof on it; after this layer hardens, clean its surface and paint again for the second time. If there is still leaking, paint the waterproof materials again for the third times. Even after, if there is still leaking at particular part, paint on the leaking area repeatedly until the leaking halt. Paint with force and repetitively with the paint waterproof materials. Assure dense painting with full attention to the connecting part. The thickness of the two layers is around 1.5 mm and the thickness of the third layer should be around 2.2 mm. Paint 2 mm macromolecular polymer on them as waterproof mortar after the

layers are harden. Moisture maintenance was carried on it for one week. The methods either placed a wet covers on it or spray water on it. Needles buried at the wet drains area of the wall and the depth should be approximately 5–8 cm. Then, polyurethane high pressure injection was injected until liquid flowing out from the surfaces of concrete around the needles. The distance between needles should be around 2 cm. During the metro station construction, it is advisable to investigate the layout of underground water leakage, surrounding environment and metro station construction structure to analyze the roots of leakage. Proper water-stop measures were adopted both internally and externally to solve the problems from the root. The waterproof construction should be under strict supervision and effective implementation was ensured [5].

4. Conclusion

With recent economy and transportation development in China, the number of metro stations is increasing. The water leaking roots should be analysed carefully to prevent leaking in the metro station and a proper preventions method should be selected. The waterproof techniques should be improved if foundation surface and waterproof layer. Proper proportion of ingredients should be used in waterproof concrete and water-stop measures should be taken effectively to ensure the quality of metro station construction. Therefore, it is important to improve the waterproof construction techniques in metro station foundation surface and waterproof layer; improve waterproof construction techniques on construction joints and induction joints; improve concrete waterproof construction and waterproof materials implementation on water-stop construction; operate scientific waterproof measures; all of the methods contribute to a secure of the metro station construction quality and facilitate a sustainable development for metro station construction corporates.

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